Chapter PS

THE TOTAL PETROLEUM SYSTEM—THE NATURAL FLUID NETWORK THAT CONSTRAINS THE ASSESSMENT UNIT

By L.B. Magoon and J.W. Schmoker

in U.S. Geological Survey Digital Data Series 60

U.S. Geological Survey

Table of Contents

Tables

Figures

ABSTRACT

The U.S. Geological Survey World Petroleum Assessment 2000 has identified, named and mapped 159 of the largest total petroleum systems (TPS's) in the world. Table 1 ranks these 159 identified systems by known size, that is by volume of cumulative production plus known reserves. This world assessment used the TPS as the basis for constraining the assessment unit (AU). The TPS is the essential elements (source, reservoir, seal, and overburden rocks) and processes (generation-migration-accumulation and trap formation) as well as all genetically related petroleum that occurs in seeps, shows, and accumulations (discovered and undiscovered) whose provenance is a pod or closely related pods of active source rock. The AU is the volume of rock within the TPS that encompasses fields, both discovered and undiscovered, which share similar geologic traits and socioeconomic factors.

A TPS investigation requires specific information necessary to explain the origin of known petroleum occurrences in three dimensional space through time and then suggests, using the AU, where undiscovered oil and gas deposits may be located. All AU's fall within the maximum geographic extent of the TPS. Known petroleum volumes in a TPS are cumulative production and remaining reported reserves. Estimated new resources in each AU are included as sizes and numbers of grown, undiscovered oil and gas fields.

For this study, the steps in the characterization of a TPS were to identify, map, and name the hydrocarbon fluid system and then to summarize the results. Bibliographic references to the geologic reports of selected TPS's are listed at the end of this chapter. These reports include (1) a TPS map, (2) TPS name, and (3) an events chart. Other information in these reports may include a TPS cross section, a table of accumulations in the TPS, and a burial history chart. This paper traces the origins of the TPS and AU, and describes how they are used in this assessment.

INTRODUCTION

Some reasons for carrying out oil-and-gas-related investigations in a geologic province are (1) to determine where to explore, or (2) to assess undiscovered commercial quantities of petroleum. Recently, published papers and meeting titles indicate the petroleum system methodology is being widely used for this purpose. In this U.S. Geological Survey World Petroleum Assessment 2000, the total petroleum system (TPS) is used to evaluate the undiscovered oil and gas resources that have the potential to be added within the next 30 years to reserves in the world, exclusive of the United States.

The most recent world assessment by the USGS in 1993 was done by petroleum basin or province (Masters and others, 1998; Schmoker and Dyman, RV) using the modified Delphi method with the geologic basin as the basic unit of assessment (Masters and others, 1992). This approach incorporated the principles of petroleum geology, published literature, and unpublished information from the petroleum industry.

In the 1995 USGS National Assessment, the United States was assessed by province using the play as the basic assessment entity (Gautier and Dolton, 1996; USGS, 1995). The play was defined for that study as a set of known or postulated oil and (or) gas accumulations sharing similar geologic, geographic, and temporal properties, such as source rock, migration patterns, timing, trapping mechanism, and hydrocarbon type.

The U.S. Geological Survey World Petroleum Assessment 2000 differs from previous assessments by using the total petroleum system (TPS) and the assessment unit (AU) (Schmoker and Klett, 1999) (AM). The 2000 assessment started by dividing the world into eight regions and 937 geologic provinces (Klett and others, 1997). Maps were developed for each region using geographic information systems (GIS)(Persits and others, 1997a,b; Pollastro and others, 1997; Schenk, 1997;

Steinshouer and others, 1997; Wandry and Law, 1997). Each region and province was named and numbered (RH). These USGS-defined province boundaries have characteristic areas of hundreds or even thousands of square kilometers encompassing a natural geologic entity, such as sedimentary basin, thrust belt, delta, or some combination of contiguous geologic entities. These provinces were then ranked by known volume of petroleum in barrels of oil equivalent (BOE) using the Petroconsultants (1996) database. The 76 largest non-U.S. geologic provinces, which together contained 95% of the non-U.S. known petroleum were deemed priority provinces (RH). Certain other provinces were designated boutique provinces for a variety of geologic, political, technical, and geographic reasons. After establishing and mapping by GIS the areas of importance, the next step was to identify and map the TPS's in each area so they could be used as the basis for defining the assessment units (AU's).

Historically, these two concepts, the TPS and AU, developed in the petroleum industry and government along two parallel tracks that began before this latest world assessment. The first track began with the oil system that evolved to the petroleum system and then to the total petroleum system. The other track started with the prospect, then to the play, and finally to the assessment unit. The concept of track one emphasizes the distribution system of the petroleum charge while track two is oriented towards the discovery of the hydrocarbon trap.

Total Petroleum System

Origin of the TPS

The term oil system was first introduced by Dow (1974) and is based on the concept of oil-source rock correlation. The term petroleum system was first used by Perrodon (1980). Independently, Demaison (1984) devised the generative basin, Meissner and others (1984) described their hydrocarbon machine, and Ulmishek (1986) identified an independent petroliferous system. All of these concepts are very similar to the oil system (Dow, 1974). Expanding upon previous work, Magoon (1987, 1988, 1989a,b. and 1992a,b) and Magoon and Dow (1994a,b) formalized the criteria for identifying, mapping, and naming the petroleum system. The petroleum system is the essential elements and processes as well as all genetically related hydrocarbons that occur in petroleum shows, seeps, and accumulations whose provenance is a single pod of active source rock (Magoon and Dow, 1994a, p. 644). Because the petroleum system included only discovered hydrocarbon, terms were needed to include undiscovered oil and gas fields, for which Magoon (1995) coined the phrases complementary plays and complementary prospects. Further, the TPS equals the petroleum system of Magoon and Dow (1994b), and the sum of all undiscovered oil and gas fields in the complementary plays and complementary prospects within that system (Magoon, 1995; Magoon and Beaumont, 1999).

For the U.S. Geological Survey World Petroleum Assessment 2000, the maximum geographic extent of the TPS was added to show the outermost boundary beyond which no oil and gas would be found. The maximum extent is that area beyond the minimum geographic extent of the TPS that lacks fields, seeps, and shows, but geology suggests that some petroleum may exist even if noncommercial (fig. PS-1). The minimum geographic extent of the TPS is the same as the geographic extent of the petroleum system of Magoon and Dow (1994b). Second, rather than use the complementary play that only included undiscovered accumulations, the assessment unit was defined to include some or all of the discovered and undiscovered accumulations in the TPS.

Definition of the TPS

The TPS is the essential elements (source rock, reservoir rock, seal rock, and overburden rock) and processes (generation-migration-accumulation and trap formation) as well as all genetically related petroleum that occurs in seeps, shows, and accumulations, both discovered and undiscovered, whose provenance is a pod or closely related pods of active source rock. The TPS is a naturally occurring hydrocarbon-fluid system in the lithosphere that can be mapped, and includes the essential elements and processes needed for oil and gas accumulations to exist. The TPS concept presumes that migration pathways must exist, either now or in the past, connecting the provenance with the accumulations.

Using principles of petroleum geology and geochemistry, this fluid system, the TPS, is mapped to better understand how it evolved over time. The goal, then, is to map this natural fluid system, or TPS, in three dimensional space through time to locate, define, and evaluate those areas for undiscovered hydrocarbons.

TPS and World Assessment

The TPS concept is the basis for this assessment as it constrains the volume of rock to be evaluated for undiscovered oil and gas accumulations. This USGS assessment named and mapped 159 of the most important TPS's in the world, exclusive of the United States. Table PS-1 ranks these systems by known petroleum volume in barrels of oil equivalent (BOE). There are four TPS's greater than 100 billion BOE, 17 TPS's ranging from 20 to 100 billion BOE, 40 TPS,s ranging from 5 to 20 billion BOE, 61 TPS's ranging from 0.2 to 5 billion BOE, and 20 TPS's that are less than 0.2 billion BOE. Also listed are 18 TPS's that are unranked. The grand total of the known volumes from each TPS is 2.4 trillion BOE.

Assessment Unit

Origin of the AU

The concept of assessment unit (AU) evolved over many years. The term prospect has been informally used by both mining and petroleum explorationists to describe present-day structural or stratigraphic features that could be mapped and drilled. A series of geologically related prospects were combined as a fairway, exploration trend, or a play. As information about petroleum geochemistry increased, the definition of a play became broader. For example, Bois (1975) defined a petroleum zone, which he considered similar to a play (Bois and others, 1982). Other definitions of a play and prospect included a source rock as well as a migration path (White, 1980, 1988; Bishop and others, 1983; Sluijk and Nederlof, 1984; Dolton and others, 1987; Bird, 1988; Gautier and Dolton, 1995). The use of quantitative petroleum geochemistry (Mackenzie and Quigley, 1988) with play and prospect evaluation provided important volumetric information for economic analysis. Magoon (1995) introduced the complementary play and complementary prospect to differentiate between discovered accumulations in the petroleum system and undiscovered oil and gas fields in the TPS. The complementary play includes one or more complementary prospects, and a complementary prospect is an undiscovered commercial accumulation within the TPS.

The U.S. Geological Survey World Petroleum Assessment 2000 was unable to use complementary play because assessment methodology required that within the total petroleum system some or all discovered accumulations needed to be compared to undiscovered oil and gas accumulations. To reduce confusion the term assessment unit (AU) was adopted. This allowed discovered fields in the AU to be the basis for the discovery history segments, which along with additional trap characteristics, were used to help estimate the number and sizes of grown, undiscovered oil and gas fields in that AU. This assessment assumes that these estimated volumes of resources have the potential to be realized over the next 30 years.

Definition of AU

The assessment unit (AU) is a volume of rock within the TPS that encompasses fields, discovered and undiscovered, sufficiently homogeneous in terms of geology, exploration strategy and risk characteristics to constitute a single population of field characteristics with respect to criteria used for resource assessment. AU’s are considered established if they contain more than 13 discovered fields, frontier if they contain 1-13 discovered fields and hypothetical if they contain no discovered fields. A unique, eight-digit numeric code identifies each AU with respect to region, province, and total petroleum system. The first digit indicates the region, the next three digits are the province, the following two digits represent the TPS (See table PS-1), and the final two digits stand for the AU (RH).

TOTAL PETROLEUM SYSTEM INVESTIGATION

The goal of a total petroleum system (TPS) investigation is to understand the geographic, stratigraphic, and temporal evolution of the system so that the resource assessment can be based upon sound geologic and geochemical concepts.

Total Petroleum System Map

The total petroleum system (TPS) map ideally includes at least six items. These items are: (1) genetically related known oil and gas accumulations, shows and seeps; (2) the pod or pods of active source rock; (3) minimum geographic extent; (4) maximum geographic extent; (5) the location of the TPS cross section; and (6) location of the locality depicted in burial history chart (fig. PS-1).

Discovered accumulations, shows, and seeps

Within a given TPS, the genetically related, discovered oil and gas fields or petroleum accumulations, by premise, originated from the same pod of active source rock. The investigator starts with a map that shows the discovered oil and gas fields in the area of interest. The investigator groups these oil and gas fields into one or more possible TPS based on their geographic and stratigraphic locations, and the bulk and geochemical properties of the fluids in each accumulation. For example, closely spaced fields that produce from the same reservoir rock are most likely charged from the same thermally mature source rock, and should be included in the same system. A similar comparison can be made of bulk chemical composition and properties, such as API gravity, that are acquired from the literature or commercial databases, such as GeoMark (1999), or Petroconsultants (1996). More detailed geochemical information might be available from the literature or the GeoMark (1999) geochemical database. In some situations, where separating two TPS's may be difficult, they are assessed together as a composite total petroleum system (See, for example Bishop, 1999a,b; Lindquist, 1998a,b,c; Pollastro, 1999).

Pod of active source rock

The pod of active source rock is a contiguous volume of source rock that generated and expelled petroleum at the critical moment and is the provenance for a group of genetically related petroleum shows, seeps, and accumulations in a TPS (fig. PS-1). The chemically active source rock includes both the mature and overmature source rock. A spent source rock is overmature. The critical moment is the time that best depicts the generation-migration-accumulation of hydrocarbons in a TPS (Magoon and Beaumont, 1999). A pod of active source rock (sometimes referred to as a "kitchen" or "oil and gas windows") may be active, inactive, or spent (Magoon and Dow, 1994a).

Within the pod boundary line is a contiguous body of rock that is or was expelling oil and gas and is identified and mapped using thermal maturity and organic richness measurements, such as vitrinite reflectance and results of Rock Eval analyses. When these geochemical data are unavailable, the location and geometry of this contiguous body of active source rock can be mapped using information about the overburden rock. For example, first, the stratigraphic interval in which the source rock occurs is determined from regional geology. Second, the thickness of overburden rocks above this source rock is determined from geologic cross sections that traverse the TPS. Third, when this overburden rock interval exceeds a certain thickness, for example, 3 kilometers, the source rock is considered thermally mature. Last, if sufficient cross sections are available, the outline of this 3-kilometer depth is then shown on the TPS map as the outline of the pod of active source rock.

Usually, a TPS has only one pod of active source rock, but for this assessment, two or more closely related pods are referred to as a composite TPS. For example, if the same source rock interval or unit overlies an area that is subsequently block faulted, and the grabens are filled with overburden rock, then this source rock becomes thermally mature in several disconnected places. By earlier definition, each pod of active source rock constitutes a single TPS. However, this assessment allows a number of pods of active source rock to be grouped together to facilitate the evaluation of undiscovered resources. Composite TPS's may also include pods whose active source rocks are of different ages.

Minimum geographic extent

The minimum geographic extent of the total petroleum system is a line that circumscribes the pod of active source rock and includes all the discovered petroleum shows, seeps, and accumulations that originated from that pod. (This minimum extent is the same line as the geographic extent of the petroleum system of Magoon and Dow, 1994a).

Maximum geographic extent

The maximum geographic extent of the total petroleum system is a line that lies beyond or coincides with the minimum geographic extent. The maximum geographic extent is mapped using geologic evidence, such as the geographic extent of the reservoir rock, that indicates the possibility that oil and gas migrated beyond the minimum geographic extent, but no hydrocarbon seeps, shows or accumulations are known.

Location of cross section

The location of the total petroleum system cross section is chosen, if possible, so that it passes through the largest oil or gas fields, the thickest overburden rock, and the maximum geographic extent of the TPS. A present-day cross section is used unless the petroleum system is so old or structurally altered that a cross section representing a previous time is required to depict the time when most of the hydrocarbons migrated. The largest accumulations are included because they are usually located on the simplest, most efficient migration path from the pod of active source rock. A transect through the thickest overburden rock shows the most likely area of thermally mature and overmature source rock. The cross section should transect the entire TPS so that the basis for the maximum geographic extent can be demonstrated. The location of the TPS cross section is shown on the TPS map (fig. PS-1). See, for example Bishop, 1999a,b; Lindquist, 1998a,b,c; Pollastro, 1999.

Location of burial history chart

The location of the burial history chart on the TPS map is shown by “X” on or near the cross-section line where the overburden rock is thickest (fig. PS-1). At this location, the source rock must be thermally mature or overmature (active). The reconstruction of the burial history at this location provides the timing of certain petroleum-related events, such as the beginning and end of hydrocarbon generation and the critical moment. See, for example Bishop, 1999a,b; Lindquist, 1998a,b,c; Pollastro, 1999.

Table of Fields

A table listing all known oil and gas accumulations included in the total petroleum system provides important information regarding discovery rates and the hydrocarbon fluid system. First, the discovery dates and sizes of the fields are used for field-size distributions and discovery-history segments. Second, the complexity of the hydrocarbon fluid system is suggested by the number of reservoir rocks. One reservoir rock common to all fields indicates a simple plumbing system (or perhaps a lack of other reservoir quality strata), whereas many different reservoir rocks indicate a complicated system. Third, the size, in recoverable BOE, of the TPS and the generation and expulsion efficiency can be determined by using the total volume of recoverable oil and gas for all fields. Fourth, the reservoir rock with the highest percentage of oil or gas reserves can be indicated in the TPS name. The construction of this field table is optional in this assessment because much of the data are confidential and cannot be reported on a field-by-field basis. See, for example Bishop, 1999a,b; Lindquist, 1998a,b,c; Pollastro, 1999.

Cross Section

The total petroleum system cross section shows the minimum and maximum geographic extents as well as the stratigraphic extent of the system and how each rock unit functions to distribute the oil and gas. The top of the active source rock, producing intervals of the oil and gas fields, and location of burial history chart are displayed. The function of each rock unit is shown, such as a petroleum source rock, reservoir rock, seal rock, or overburden rock. See, for example Bishop, 1999a,b; Lindquist, 1998a,b,c; Pollastro, 1999.

Total Petroleum System Name

The total petroleum system name labels the hydrocarbon-fluid system or distribution network, and can include the geological formation names of the source rock followed by the major reservoir, and the level of certainty. Generally, the name used in this world assessment is one that best describes the TPS for the assessment team. The names of all TPS in this assessment are listed in table PS-1.

The level of certainty is the measure of confidence that petroleum from a series of genetically related accumulations originated from a specific pod of active source rock. Three levels used are known, hypothetical, and speculative, depending on the level of geochemical, geophysical and geologic evidence.

Burial History Chart

The burial history chart summarizes the sedimentologic and paleontologic evidence in the overburden rock used to reconstruct the burial or thermal history of the source rock so that the beginning and end of petroleum expulsion and accumulation, and the critical moment can be depicted (fig. PS-2). The beginning of generation-migration-accumulation usually occurs when the source rock reaches a vitrinite reflectance equivalence of 0.6±0.1% Ro, and ends when the source rock is uplifted, or is depleted as it is more deeply buried. The location of the burial history chart is shown on the TPS map and on the cross section. See, for example Bishop, 1999a,b; Lindquist, 1998a,b,c; Pollastro, 1999.

Events Chart

The events chart shows the temporal relationship of the rock units, essential elements, processes, preservation time, and critical moment for each total petroleum system in bar graph form. The template for the events chart was revised for the World Petroleum Assessment 2000 (fig. PS-3). The revisions included replacing the Palmer (1983) time scale with the time scale by Harland and others (1989) for the Paleozoic, Gradstein and others (1994) for the Mesozoic, and by Berggren and others (1995) for the Cenozoic. Also included are the ages of worldwide source rock intervals and their volume percentage contribution to the known oil and gas (Ulmishek and Klemme, 1990).

In order for an evolving TPS to effectively trap migrating hydrocarbon fluids, the trap forming process must occur before or during the generation-migration-accumulation process. This simple bar graph quickly shows the order of these processes.

An events chart has the following characteristics. First, there is usually only one active source rock for each TPS, however, in this assessment, several source rock intervals may be combined (composite TPS). Second, every reservoir rock needs a seal, no matter how thin. Third, reservoir rocks are shown that contain, or could contain, petroleum accumulations, shows, or seeps. Fourth, eroded overburden rock is shown so that it can be incorporated into the burial depth model. Fifth, information for timing of trap formation comes from cross sections through oil and gas fields. Sixth, the best information for generation-migration-accumulation is from source rock burial modeling and kinetics. This information indicates the beginning, peak, and end of generation or when the active source rock is depleted (spent) or uplifted (inactive source rock). Seventh, preservation time is defined as that time when generation-migration-accumulation ends and continues to present. If generation-migration-accumulation ends today or is still going on, there is no preservation time. Young TPS's usually have no preservation time. Last, the critical moment is the time that best depicts the generation-migration-accumulation of hydrocarbons in a TPS, and its selection relies on the judgement of the investigator. Modeling packages, such as Basin2 (Bethke and others, 1999), that show peak generation within the pod of active source rock provide excellent guides.

SUMMARY

The U.S. Geological Survey World Petroleum Assessment 2000 used the total petroleum system concept as the basis for constraining the assessment unit. The assessment process started by dividing the world into eight regions and 937 geologic provinces. These provinces were ranked according to the known petroleum volumes within each; 76 high-ranking or priority provinces and 26 boutique provinces, were chosen as the areas to be evaluated for undiscovered oil and gas resources. In each of these areas, the total petroleum systems (TPS's) were identified, named and mapped so that they could be used as the basis for establishing the assessment units (AU's) to be evaluated for undiscovered oil and gas resources.

This USGS assessment named and mapped 159 of the most important TPS's in the world, exclusive of the United States, accounting for about 2.4 trillion BOE in cumulative production and known reserves. Table PS-1 ranks these TPS's by known resources.

A TPS includes the essential elements and processes, as well as all genetically related hydrocarbons that occur in petroleum shows, seeps and accumulations, both discovered and undiscovered, whose provenance is a pod or closely related pods of active source rock. The AU is a mapped volume of rock within the TPS, sufficiently homogeneous in terms of geology, exploration strategy and risk characteristics to constitute a single population of discovered and undiscovered fields with respect to criteria used for resource assessment. AU's are considered established if they contain more than 13 discovered fields, frontier if they contain 1-13 discovered fields and hypothetical if they contain no discovered fields.

REFERENCES CITED

Berggren, W.A., Kent, D.V., Swisher, C.C. III, and Aubry, M.P., 1995, A revised Cenozoic geochronology and chronostratigraphy: Geochronology, Time Scales, and Global Stratigraphic Correlation, SEPM (Society for Sedimentary Geology), p. 129-212.

Bethke, C. M., Lee, M.K., and Park, J. 1999, Basin modeling with Basin2, A Guide to using the Basin2 software package, Release 4: Hydrogeology Program, University of Illinois, Urbana, Illinois, 205 p.

Bird, K.J., 1988, The geologic basis for appraising undiscovered hydrocarbon resources in the National Petroleum Reserve of Alaska by the play-appraisal method, *in* Gryc, George, ed., Geology of the National Petroleum Reserve in Alaska: U.S. Geological Survey Professional Paper 1399, p. 81-116.

Bishop, M.B., 1999a, A total petroleum system of the Browse Basin, Australia: The Dingo-Mungaroo/Barrow and the Locker-Mungaroo/Barrow: U.S. Geological Survey Open-File Report 99-50E.

Bishop, M.B., 1999b, A total petroleum system of the Browse Basin, Australia: Late Jurassic/Early Cretaceous-Mesozoic: U.S. Geological Survey Open-File Report 99-50I.

Bishop, R.S., Gehman, Jr., H.M., and Young, Allen, 1983, Concepts for estimating hydrocarbon accumulation and dispersion: American Association of Petroleum Geologists Bulletin, v. 67, p. 337-348.

Bois, C., 1975, Petroleum-zone concept and the similarity analysis contribution to resource appraisal, *in* Haun, J.D., ed., Methods of estimating the volume of undiscovered oil and gas resources: American Association of Petroleum Geologists Studies in Geology 1, p. 87-89.

Bois, C., Bouche, P. and Pelet, R., 1982, Global geologic history and distribution of hydrocarbon reserves: American Association of Petroleum Geologists Bulletin, v. 66, no. 9, p. 1248-1270.

Demaison, G., 1984, The generative basin concept, *in* Demaison, G. and Murris, R.J., eds., Petroleum geochemistry and basin evaluation: American Association of Petroleum Geologists Memoir 35, p. 1-14.

Dolton, G.L., Bird, K.J. and Crovelli, R.A., 1987, Assessment of in-place oil and gas resources, *in* Bird, K.J. and Magoon, L.B., eds., Petroleum geology of the northern part of the Arctic National Wildlife Refuge, northeastern Alaska: U.S. Geological Survey Bulletin 1778, p. 277-298.

Dow, W.G., 1974, Application of oil-correlation and source-rock data to exploration in Williston basin: American Association of Petroleum Geologists Bulletin, v. 58, no. 7, p. 1253-1262.

Gautier, D.L. and Dolton, G.L., 1996, Methodology for assessment of conventional accumulations, *in* Gautier, D.L., Dolton, G.L., Takahashi, K.T., and Varnes, K.L., eds., 1995 National assessment of United States oil and gas resources¾ Results, methodology, and supporting data: U.S. Geological Survey Digital Data Series DDS-30, v. 2, 1 CD-ROM..

GeoMark, 1999, Oils 99, Oil information library system database, Houston, Texas, GeoMark Research, Inc. [database available from GeoMark Research, Inc., 9748 Whithorn Drive, Houston, Texas 77095].

Gradstein, F.M., Agterberg, F.P., Ogg, J.G., Hardenbol, J., van Veen, P., Thierry, J., and Huang, Z, 1994, A Mesozoic time scale: Journal of Geophysical Research, v. 99, no. B12, p. 24,051-24,074.

Harland, W.B., Armstrong, R.L., Cox, A.V., Craig, L.E., Smith, A.G., and Smith, D.G., 1989, A geologic time scale 1989: Cambridge University Press, Cambridge, 163 p.

Klett, T.R., Ahlbrandt, T.S., Schmoker, J.W., and Dolton, G.L., 1997, Ranking of the world's oil and gas provinces by known petroleum volumes: U.S. Geological Survey Open File Report 97-463, 1 CD-ROM.

Lindquist, S.J., 1998a, The Santa Cruz-Tarija province of central South America: Los Monos-Machareti(!) petroleum system: U.S. Geological Open-file 99-50C.

Lindquist, S.J., 1998b, The Red Sea basin province: Sudr-Nubia(!) and Maqna(!) petroleum systems: U.S. Geological Survey Open-file 99-50A.

Lindquist, S.J., 1998c, The Timan-Pechora basin province of northwest Arctic Russia: Domanik – Paleozoic Total Petroleum System: U. S. Geological Survey Open-file 99-50G.

Mackenzie, A.S. and Quigley, T.M., 1988, Principles of geochemical prospect appraisal: American Association of Petroleum Geologists Bulletin, v. 72, p. 399-415.

Magoon, L.B., 1987, The petroleum system—A classification scheme for research, resource assessment and exploration [*abs.*]: American Association of Petroleum Geologists Bulletin, v. 71, no. 5, p. 587.

Magoon, L.B., 1988, The petroleum system—A classification scheme for research, exploration, and resource assessment, *in* Magoon, L.B., Petroleum systems of the United States: U.S. Geological Survey Bulletin 1870, p. 2-15.

Magoon, L.B., ed., 1989a, The petroleum system—Status of research and methods, 1990: U.S. Geological Survey Bulletin 1912, 88 p.

Magoon, L.B., 1989b, Identified petroleum systems within the United States--1990, *in* Magoon, L.B., ed., The petroleum system—Status of research and methods, 1990: U.S. Geological Survey Bulletin 1912, p.2-9.

Magoon, L.B., ed., 1992a, The petroleum system—Status of research and methods, 1992: U.S. Geological Survey Bulletin 2007, 98 p.

Magoon, L.B., 1992b, Identified petroleum systems within the United States—1992, *in* Magoon, L.B., ed., The petroleum system—Status of research and methods, 1992: U.S. Geological Survey Bulletin 2007, p. 2-11.

Magoon, L.B., 1995, The play that complements the petroleum system—a new exploration equation: Oil and Gas Journal, v. 93, no. 40, p. 85-87.

Magoon, L.B., and Beaumont, E.A., 1999, Petroleum system, in Beaumont, E.A. and Foster, N.H., eds., Exploring for oil and gas traps: American Association of Petroleum Geologists Treatise of Petroleum Geology, Chap. 3, p. 3.1-3.34.

Magoon, L.B., and Dow, W.G., eds., 1994a, The petroleum system—From source to trap: American Association of Petroleum Geologists Memoir 60, 655 p.

Magoon, L.B., and Dow, W.G., 1994b, The Petroleum System, *in* Magoon, L.B. and Dow, W.G., eds., The petroleum system—From source to trap: American Association of Petroleum Geologists Memoir 60, p. 3-24.

Masters, C. D., Root, D. H., and Attanasi, E. D., 1992, World resources of crude oil and natural gas: Proceedings of the 13th World Petroleum Congress, v.2, p. 51-64.

Masters, C.D., Root, D. H., and Turner, R. M., 1998, World Conventional Crude Oil and Natural Gas: Identified Reserves, Undiscovered Resources and Futures: U.S. Geological Survey Open File Report 98-468 (August) 105, p. 2 plates.

Meissner, F.F., Woodward, J., and Clayton, J.L., 1984, Stratigraphic relationships and distribution of source rocks in the greater Rocky Mountain region, *in* Woodward, J., Meissner, F.F., and Clayton, J.L., eds., Hydrocarbon source rocks of the greater Rocky Mountain region: Denver, Rocky Mountain Association of Geologists, p. 1-34.

Palmer, A.R., 1983, The Decade of North American Geology 1983 Geologic Time Scale: The Geologic Society of America, 2 p.

Perrodon, A., 1980, Géodynamique pétrolière. Genèse et répartition des gisements d'hydrocarbures: Paris, Masson–Elf-Aquitaine, 381 p.

Persits, F.M., Ahlbrandt, T.S., Tuttle, M., Charpentier, R., Brownfield, M., and Takahashi, K., 1997a, Map showing geology, oil and gas fields, and geological provinces of Africa: U.S. Geological Survey Open-File 97-470A, 1 CD-ROM.

Persits, F.M., Ulmishek, G.F., and Steinshouer, D.W., 1997b, Map showing geology, oil and gas fields, and geologic provinces of the Former Soviet Union: U.S. Geological Survey Open-File 97-470E, CD-ROM.

Petroconsultants, 1996, Petroleum exploration and production database: Houston, Texas, Petroconsultants, Inc. [database available from Petroconsultants, Inc., P.O. Box 740619, Houston,Texas 77274-0619 USA].

Pollastro, R.M., Viger, R.J., and Karshbaum, A.S., 1997, Map showing geology, oil and gas fields, and geologic provinces of the Arabian Peninsula, U.S. Geological Society Open-File 97-470B, 1 CD-ROM.

Pollastro, R.M., 1999, Ghaba salt basin province and Fahud salt basin province, Oman--geological overview and total petroleum systems: U.S. Geological Survey Bulletin 2167, 41 p.

Schenk, C.J., 1997, Map showing geology, oil and gas fields, and geologic provinces of South America: U.S. Geological Survey Open-File 97-470D, 1 CD-ROM.

Schmoker, J. W., and Klett, T. R., 1999, U.S. Geological Survey assessment model for undiscovered conventional oil, gas, and NGL resources - The Seventh Approximation: U.S. Geological Survey Bulletin 2165, 7 p.

Steinshouer, D.W., Qiang, J., McCabe, P.J., and Ryder, R.T., 1997, Maps showing geology, oil and gas fields and geologic provinces of the Asia Pacific Region: U. S. Geological Survey Open-file Report 97-470F, 1 CD-ROM.

Sluijk, D., and Nederlof, M.H., 1984, Worldwide geological experience as a systematic basis for prospect appraisal, *in* Demaison, G. and Murris, R.J., eds., Petroleum geochemistry and basin evaluation: American Association of Petroleum Geologists Memoir 35, p. 15-26.

Tuttle, M.L.W., Charpentier, R.R., and Brownfield, M.E., 1999, The Niger Delta Petroleum System: Niger Delta Province, Nigeria, Cameroon, and Equatorial Guinea, Africa: U.S. Geological Survey Open-file Report 99-50H.

Ulmishek, G.F., 1986, Stratigraphic aspects of petroleum resource assessment, *in* Rice, D.D., ed., Oil and gas assessment--Methods and applications: American Association of Petroleum Geologists Studies in Geology #21, p. 59-68.

Ulmishek, G.F. and Klemme, H.D., 1990, Depositional Controls, Distribution, and Effectiveness of World's Petroleum Source Rocks: U.S. Geological Survey Bulletin 1931, 59 p.

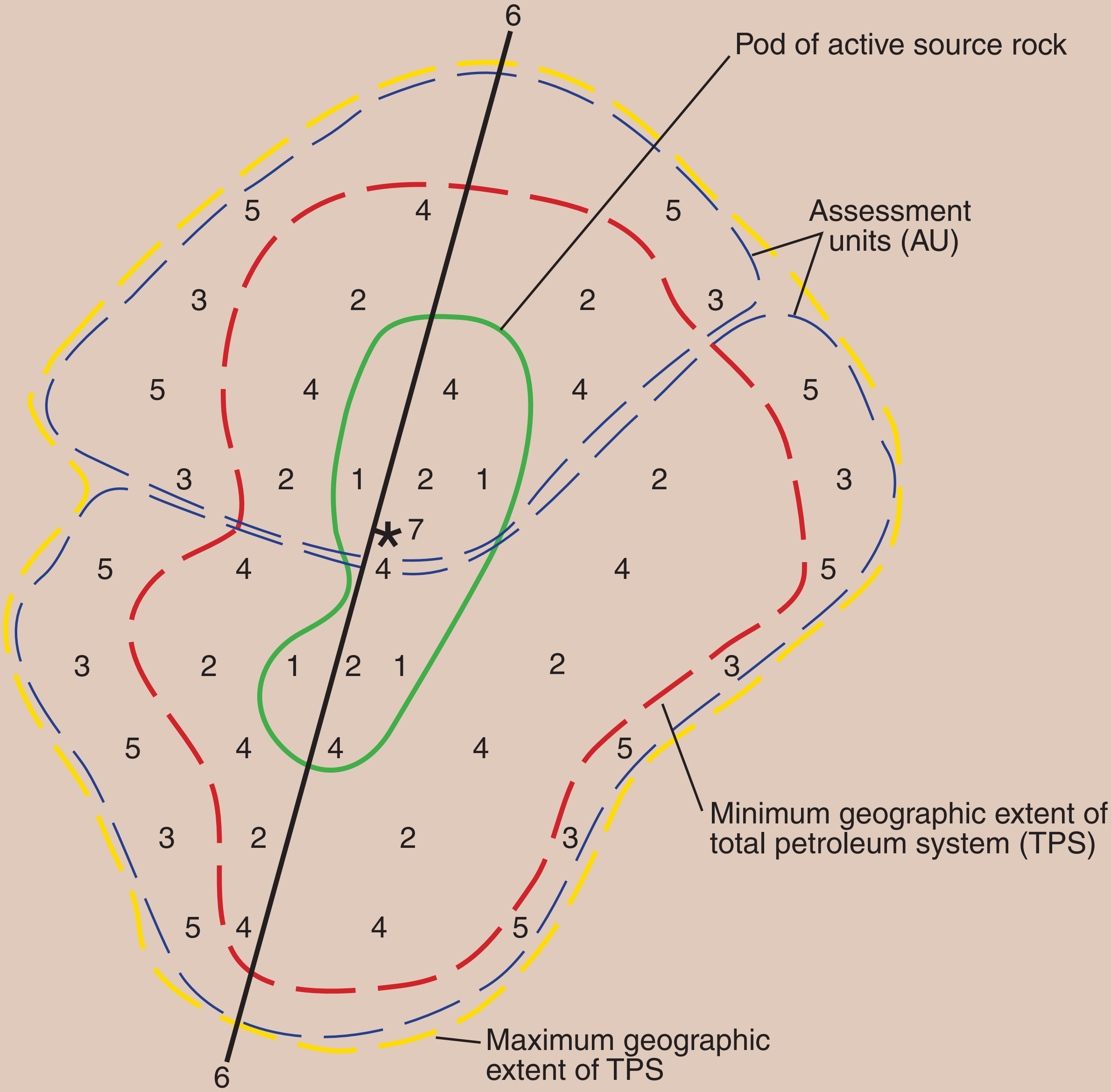
United States Geological Survey, 1995, National Oil and Gas Resource Assessment Team, 1995 National Assessment of United States Oil and Gas Resources: U. S. Geological Survey Circular 1118, 20 p.

Wandrey, C.J., and Law, B.E., 1997, Maps showing geology, oil and gas fields and geological provinces of South Asia: U.S. Geological Survey Open-file Report 97-470C, 1 CD-ROM.

White, D.A., 1980, Assessing oil and gas plays in facies-cycle wedges: American Association of Petroleum Geologists Bulletin, v. 64, no. 8, p. 1158-1178.

White, D.A., 1988, Oil and gas play maps in exploration and assessment: American Association of Petroleum Geologists Bulletin, v. 72, no. 8, p. 944-949.

Total Petroleum System Map



EXPLANATION of numbered areas:

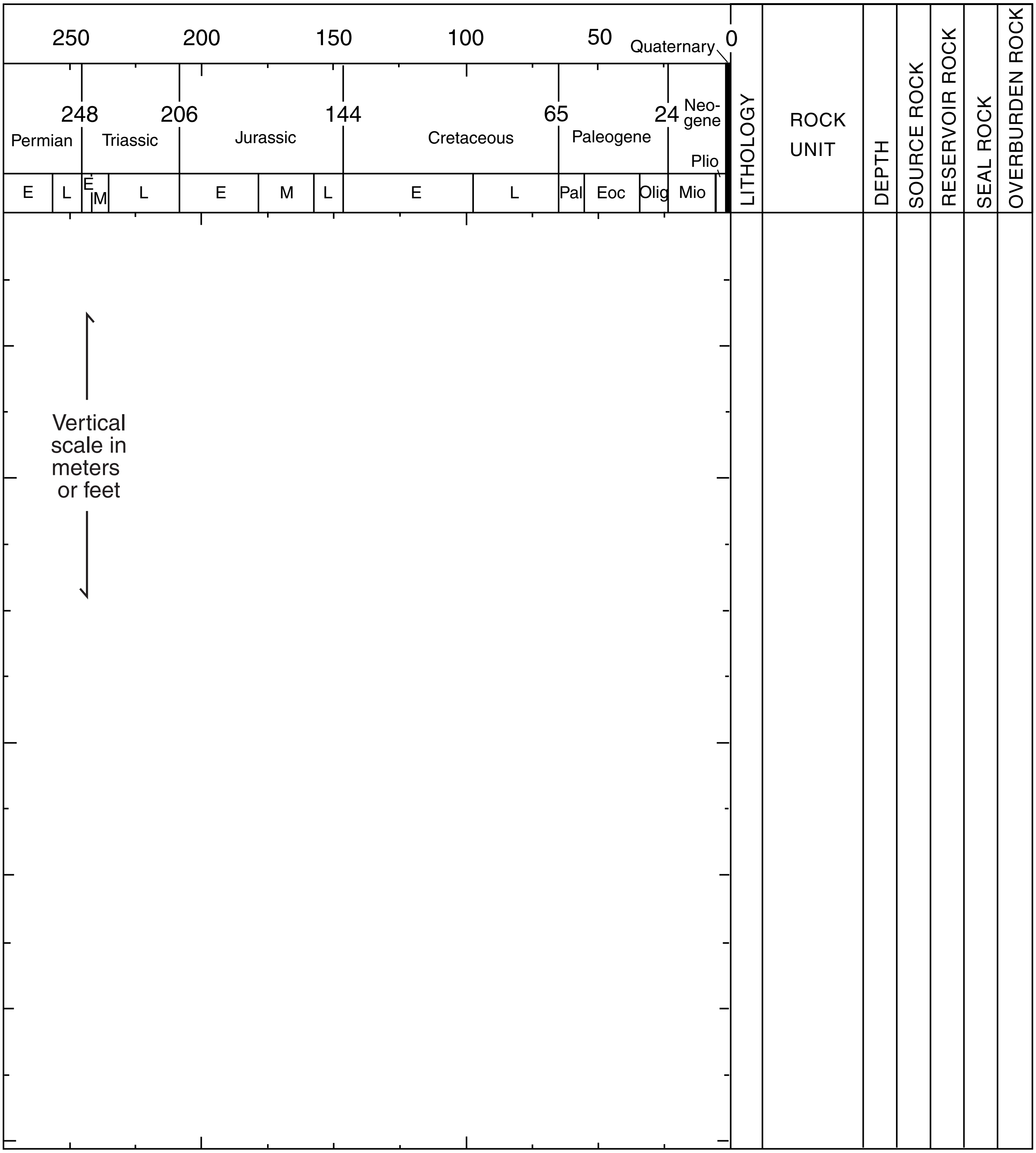
1. Area of the pod of active source rock which contains contiguous body of mature or overmature (active) organic-rich rock that is provenance of hydrocarbons for this total petroleum system (TPS).
2. Area of the minimum geographic extent of TPS. Contains known oil and gas fields, seeps, and shows.
3. Area between minimum and maximum geographic extents of TPS. Area lacks known fields, seeps, and shows but geology suggests that petroleum accumulations may exist.
4. Area of the assessment unit (AU) that contains known oil and gas fields.
5. Area of the AU that lacks known fields.
6. Location of TPS cross section.
7. Location of TPS burial history chart.

Figure 1

Total Petroleum System Burial History Chart

Province Name:______________ TPS Name: ____________________________

Author(s):____________________ Date:_______________



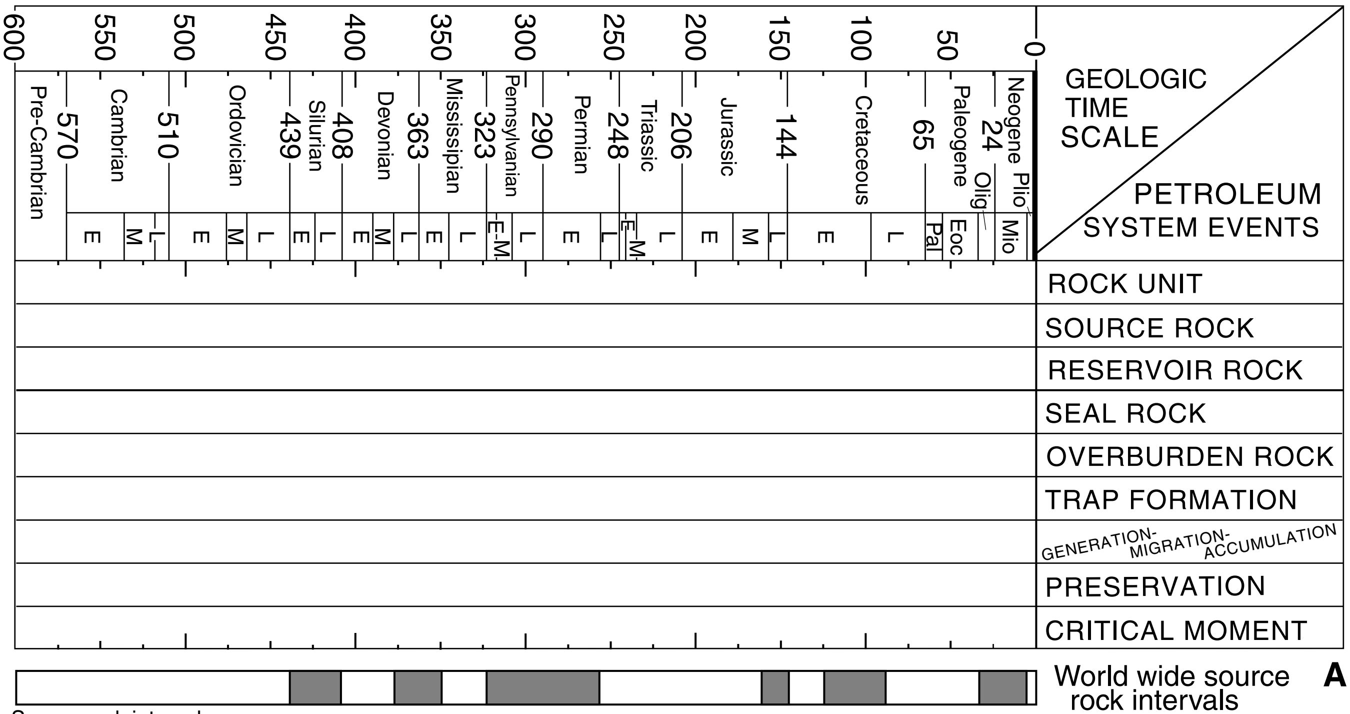
Time scale: Harland et al., 1989; Gradstein et al., 1994; Berggren et al., 1995

Figure 2

Total Petroleum System Events Chart

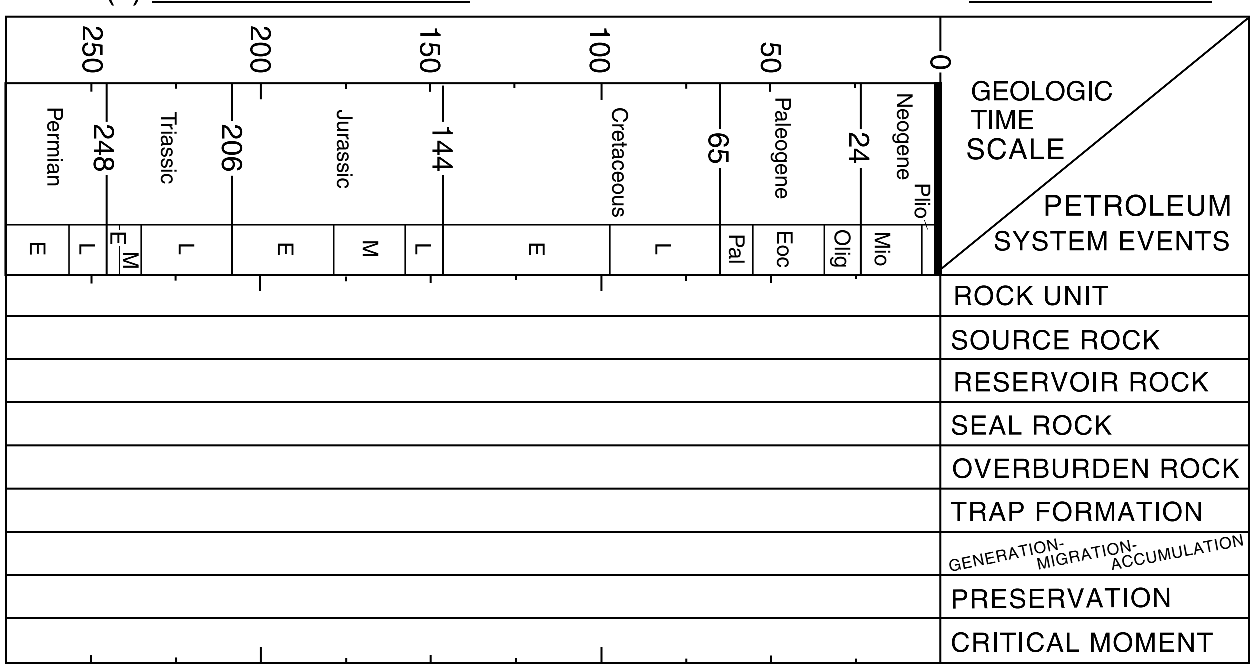
Province Name:____________________ TPS Name: ________________________

Author(s):__________________________ Date:______________



Province Name:______________ TPS Name: ________________________

Author(s):___________________ Date:______________



Time scale: Harland et al., 1989; Gradstein et al., 1994; Berggren et al., 1995

Figure 3 B

Table 1. Summary of the total petroleum systems ranked by known petroleum volume (in MMBOE) that were assessed in the U.S. Geological Survey World Petroleum Assessment 2000. [B, barrels; O, oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MM, millions; BOE, barrels of oil equivalent at 1 barrel oil to 6000 cubic feet of gas. Known petroleum volume equates to cumulative production plus remaining reserves and are from Petroconsultants,1996]

Total Petroleum System (TPS) Name	TPS Code	Region Name	Known Oil (MMBO)	Known Gas (BCFG)	Known NGL (MMBNGL)	Total Known (MMBOE)	Total Known (MMBOE)
>100 Billion BOE							
Zagros-Mesopotamian Cretaceous-Tertiary	203001	Middle East and North Africa	372,226	493,238	1,562	455,995	
Arabian Sub-Basin Tuwaiq/Hanifa-Arab	202102	Middle East and North Africa	198,995	275,295	9,205	254,083	
Northern West Siberian Mesozoic Composite	117403	Former Soviet Union	10,185	1,167,288	2,375	207,107	
Bazhenov-Neocomian	117401	Former Soviet Union	117,972	97,582	764	135,000	1,052,185
20-100 Billion BOE							
Cretaceous Thamama/Wasia	201901	Middle East and North Africa	71,231	102,100	1,901	90,148	
Silurian Qusaiba	201903	Middle East and North Africa	555	452,030	13,815	89,708	
Volga-Ural Domanik-Paleozoic	101501	Former Soviet Union	63,872	96,458	1,096	81,044	
Kimmeridgian Shales	402501	Europe	43,895	158,914	5,971	76,351	
La Luna/Maracaibo	609901	Central and South America	49,072	26,701	43	53,565	
Tertiary Niger Delta (Agbada/Akata)	719201	Sub-Saharan Africa and Antarctica	34,522	93,811	2,842	53,000	
Pimienta-Tamabra	530501	North America	44,412	50,822	95	52,977	
Querecual	609801	Central and South America	26,756	112,296	528	46,001	
Paleozoic North Caspian	101601	Former Soviet Union	10,808	156,976	8,890	45,861	
Sirte-Zelten	204301	Middle East and North Africa	37,072	37,767	129	43,496	
Amu-Darya Jurassic-Cretaceous	115401	Former Soviet Union	766	230,614	1,175	40,377	
Carboniferous-Rotliegend	403601	Europe	2,872	222,159	172	40,071	
Jurassic Hanifa/Diyab-Arab	201902	Middle East and North Africa	19,013	77,512	592	32,523	
Shahejie-Shahejie/Guantao/Wumishan	312701	Asia Pacific	24,553	15,672	88	27,253	
Oligocene-Miocene Maykop/Diatom	111201	Former Soviet Union	17,438	35,994	503	23,941	
Paleozoic-Permian/Triassic	203002	Middle East and North Africa	0	131,220	925	22,795	
Tanezzuft-Benoud	205805	Middle East and North Africa	88	105,050	4,935	22,531	841,642
5-20 Billion BOE							
Central Arabia Qusaiba Paleozoic	202101	Middle East and North Africa	6,376	79,115	343	19,905	
Domanik-Paleozoic	100801	Former Soviet Union	13,069	36,632	716	19,890	
Qingshankou-Putaohua/Shaertu	314401	Asia Pacific	15,570	1,598	0	15,836	
Brown Shale-Sihapas	380801	Asia Pacific	13,217	3,866	11	13,872	
South and North Barents Triassic-Jurassic	105001	Former Soviet Union	51	78,143	100	13,175	
Brunei-Sabah	370101	Asia Pacific	6,898	36,200	180	13,111	
Duvernay-Leduc	524302	North America	9,459	14,357	1,025	12,877	
Eocene-Miocene Composite	804301	South Asia	8,440	24,193	267	12,739	

Total Petroleum System (TPS) Name	TPS Code	Region Name	Known Oil (MMBO)	Known Gas (BCFG)	Known NGL (MMBNGL)	Total Known (MMBOE)	Total Known (MMBOE)
Togur-Tyumen	117402	Former Soviet Union	11,756	5,180	3	12,623	
Tanezzuft-Oued Mya	205401	Middle East and North Africa	10,843	8,973	0	12,338	
Tanezzuft-Illizi	205601	Middle East and North Africa	3,670	45,061	898	12,078	
Kutei Basin	381701	Asia Pacific	2,879	45,473	1,273	11,731	
Dnieper-Donets Paleozoic	100901	Former Soviet Union	1,611	59,098	200	11,660	
Congo Delta Composite	720303	Sub-Saharan Africa and Antarctica	9,745	9,443	39	11,357	
Lagoa Feia-Carapebus	603501	Central and South America	10,056	6,244	10	11,107	
Sudr-Nubia	207101	Middle East and North Africa	9,810	5,995	41	10,850	
Dingo-Mungaroo/Barrow	394801	Asia Pacific	1,149	48,245	991	10,181	
Gacheta-Mirador	609601	Central and South America	5,402	15,314	451	8,405	
Tanezzuft-Ghadames	205403	Middle East and North Africa	4,538	16,484	1,011	8,296	
East Natuna	370202	Asia Pacific	20	45,045	0	7,528	
Second White Specks-Cardium	524306	North America	2,688	26,449	365	7,462	
Baikal-Patom Foldbelt Riphean-Craton Margin Vendian	121001	Former Soviet Union	2,006	30,210	360	7,401	
Sarawak Basin	370201	Asia Pacific	797	37,119	379	7,363	
Oligocene-Miocene Lacustrine	370301	Asia Pacific	3,017	24,248	136	7,194	
Lucaogou-Karamay/Ulho/Pindequan	311501	Asia Pacific	6,624	2,248	0	6,998	
Mesozoic-Cenozoic	604101	Central and South America	6,601	1,616	0	6,871	
Upper Cretaceous/Tertiary	609802	Central and South America	3,447	15,822	172	6,256	
South Mangyshlak	110902	Former Soviet Union	5,241	5,707	46	6,239	
Latrobe	393001	Asia Pacific	3,860	9,775	701	6,190	
Neuquen Hybrid	605501	Central and South America	2,370	20,704	338	6,159	
Exshaw-Rundle	524303	North America	1,728	21,568	836	6,158	
Sembar-Goru/Ghazij	804201	South Asia	180	35,373	63	6,139	
North Sakhalin Neogene	132201	Former Soviet Union	2,182	22,383	165	6,077	
Upper Jurassic Spekk	401701	Europe	2,660	15,662	702	5,973	
North Oman Huqf/'Q'-Haushi	201401	Middle East and North Africa	2,028	20,339	507	5,925	
Bampo-Cenozoic	382201	Asia Pacific	674	25,559	926	5,860	
Mannville-Upper Mannville	524305	North America	0	30,731	447	5,569	
Lower Inoceramus	605901	Central and South America	1,216	24,807	211	5,562	
Transylvanian Composite	405701	Europe	0	30,731	0	5,122	
Madbi Amran/Qishn	200401	Middle East and North Africa	1,933	17,120	312	5,098	375,175
0.2-5 Billion BOE							
Dysodile Schist-Tertiary	406102	Europe	4,115	5,048	11	4,968	
Terek-Caspian	110901	Former Soviet Union	3,490	7,840	29	4,826	
Miocene Coaly Strata	370302	Asia Pacific	592	23,901	186	4,761	
Bou Dabbous-Tertiary	204801	Middle East and North Africa	2,114	15,509	44	4,743	
Lahat/Talang Akar-Cenozoic	382801	Asia Pacific	2,429	10,204	56	4,186	

Total Petroleum System (TPS) Name	TPS Code	Region Name	Known Oil (MMBO)	Known Gas (BCFG)	Known NGL (MMBNGL)	Total Known (MMBOE)	Total Known (MMBOE)
North Oman Huqf-Shu'aiba	201601	Middle East and North Africa	2,685	7,633	58	4,015	
D-129	605801	Central and South America	3,346	3,565	2	3,942	
Lower Cruse	610301	Central and South America	20	22,600	80	3,867	
Los Monos-Machareti	604501	Central and South America	320	16,985	548	3,699	
Azov-Kuban Mesozoic-Cenozoic	110801	Former Soviet Union	524	18,704	56	3,696	
Sylhet-Kopili/Barail-Tipam Composite	803401	South Asia	2,536	6,534	5	3,630	
Combined Triassic/Jurassic	524304	North America	1,296	10,580	350	3,409	
La Luna-La Paz	609001	Central and South America	2,426	5,002	68	3,328	
Jatibarang/Talang Akar-Oligocene/Miocene	382402	Asia Pacific	1,908	7,322	175	3,303	
Late Jurassic/Early Cretaceous-Mesozoic	391301	Asia Pacific	46	17,960	200	3,239	
Porto Garibaldi	406001	Europe	14	18,475	5	3,098	
Stavropol-Prikumsk	110903	Former Soviet Union	820	13,499	3	3,073	
Lodgepole	524404	North America	2,778	893	37	2,964	
Greater Hungarian Plain Neogene	404801	Europe	1,089	9,657	24	2,722	
Middle Cretaceous Natih	201602	Middle East and North Africa	1,852	3,100	100	2,469	
Eocene to Miocene Composite	804801	South Asia	716	10,020	63	2,449	
Buzuchi Arch and Surrounding Areas Composite	115001	Former Soviet Union	2,286	943	0	2,443	
Azile-Senonian	720302	Sub-Saharan Africa and Antarctica	2,114	1,835	10	2,430	
Egret-Hibernia	521501	North America	1,582	2,406	81	2,393	
Keg River-Keg River	524301	North America	1,011	7,073	100	2,290	
Moesian Platform Composite	406101	Europe	1,793	2,217	66	2,228	
Cretaceous-Tertiary	608101	Central and South America	1,672	2,892	0	2,154	
Jurassic/Early Cretaceous-Mesozoic	391003	Asia Pacific	502	7,526	385	2,141	
Jenam/Bhuban-Bokabil	804703	South Asia	4	12,289	51	2,104	
Melania-Gamba	720301	Sub-Saharan Africa and Antarctica	1,752	843	15	1,908	
Ordovician/Jurassic-Phanerozoic	315401	Asia Pacific	704	5,780	189	1,856	
Maokou/Longtang-Jialingjiang/Maokou/Huanglong	314201	Asia Pacific	0	11,072	0	1,846	
Mesozoic/Paleogene Composite	404702	Europe	923	5,393	6	1,828	
Zala-Drava-Sava Mesozoic/Neogene	404802	Europe	1,101	3,929	63	1,818	
Isotopically Light Gas	404701	Europe	1	10,660	3	1,782	
Paleozoic Qusaiba/Akkas/Abba/Mudawwara	202301	Middle East and North Africa	1,213	1,661	25	1,515	
Banuwati-Oligocene/Miocene	382401	Asia Pacific	1,259	614	0	1,362	
Locker-Mungaroo/Barrow	394802	Asia Pacific	6	8,102	0	1,356	
Keyling/Hyland Bay-Permian	391002	Asia Pacific	0	5,730	50	1,005	
Cretaceous Composite	730301	Sub-Saharan Africa and Antarctica	0	6,015	0	1,003	
Maqna	207102	Middle East and North Africa	155	3,527	256	999	
Yenisey Foldbelt Riphean-Craton Margin Riphean	120701	Former Soviet Union	34	5,052	60	936	
Taiyuan/Shanxi-Majiagou/Shihezi	312802	Asia Pacific	0	5,590	0	932	

Total Petroleum System (TPS) Name	TPS Code	Region Name	Known Oil (MMBO)	Known Gas (BCFG)	Known NGL (MMBNGL)	Total Known (MMBOE)	Total Known (MMBOE)
Neocomian to Turonian Composite	602901	Central and South America	692	1,407	3	929	
Mesozoic Composite	521502	North America	0	4,224	107	804	
Tanezzuft-Timimoun	205801	Middle East and North Africa	0	4,200	0	700	
Patala-Namal	802601	South Asia	324	1,981	41	696	
Yanchang-Yanan	312801	Asia Pacific	683	20	0	686	
Tanezzuft-Ahnet	205802	Middle East and North Africa	1	3,117	90	610	
Cretaceous Composite	718301	Sub-Saharan Africa and Antarctica	236	1,949	36	596	
Tanezzuft-Sbaa	205803	Middle East and North Africa	284	1,490	10	542	
Guaratiba-Guaruja (Cretaceous) Composite	603601	Central and South America	285	1,125	44	517	
Belsk Basin	101502	Former Soviet Union	65	2,638	5	509	
Jurassic Gotnia/Barsarin/Sargelu/Najmah	202302	Middle East and North Africa	474	100	0	490	
Meride/Riva di Solto	406002	Europe	332	412	27	428	
Jurassic-Cretaceous Composite	204802	Middle East and North Africa	103	1,301	23	343	
North Ustyurt Jurassic	115002	Former Soviet Union	80	1,450	8	330	
Upper Jurassic-Neocomian	611701	Central and South America	297	96	0	313	
Jurassic Coal-Jurassic/Tertiary	311502	Asia Pacific	210	342	0	267	
Cambrian/Silurian Marine Shale-Dengying/Lower Paleozoic	314204	Asia Pacific	1	1,350	0	226	123,702
<200 MMBOE							
Cretaceous-Paleogene	608302	Central and South America	171	158	0	197	
Cretaceous Composite	603401	Central and South America	130	222	1	169	
Daanzhai-Daanzhai/Lianggaoshan	314202	Asia Pacific	109	140	0	132	
Cuanza Composite	720304	Sub-Saharan Africa and Antarctica	107	59	0	116	
Cenomanian-Turonian	602101	Central and South America	63	0	0	63	
Neogene	608301	Central and South America	4	340	0	61	
Transcarpathian Neogene	404804	Europe	0	261	0	43	
Danube Neogene	404803	Europe	0	247	0	41	
Paleozoic Composite	404703	Europe	1	233	0	39	
Tanezzuft-Melrhir	205402	Middle East and North Africa	6	125	9	36	
Jurassic Coal-Denglouku/Nongan	314402	Asia Pacific	5	145	0	29	
Lower Cretaceous Marine	606301	Central and South America	10	75	2	25	
Milligans-Carboniferous/Permian	391001	Asia Pacific	15	48	0	23	
Tertiary-Parigi	382403	Asia Pacific	0	119	0	20	
Cretaceous-Tertiary Composite	701301	Sub-Saharan Africa and Antarctica	10	49	0	19	
Brightholme	524402	North America	14	11	0	16	
Hungarian Paleogene	404806	Europe	11	16	0	14	
Tobago Trough Paleogene	610701	Central and South America	11	22	0	14	
Bakken	524403	North America	7	0	0	7	
Yeoman	524401	North America	1	0	0	1	1,214

Total Petroleum System (TPS) Name	TPS Code	Region Name	Known Oil (MMBO)	Known Gas (BCFG)	Known NGL (MMBNGL)	Total Known (MMBOE)	Total Known (MMBOE)
Unranked Total Petroleum Systems							
Tanezzuft-Mouydir	205804	Middle East and North Africa	0	0	0	0	
Tanezzuft-Bechar/Abadla	205806	Middle East and North Africa	0	0	0	0	
Lucaogou/Jurassic Coal-Paleozoic/Mesozoic	311503	Asia Pacific	0	0	0	0	
Carboniferous/Permian Coal-Paleozoic	312702	Asia Pacific	0	0	0	0	
Tertiary-Cenozoic	382404	Asia Pacific	0	0	0	0	
Pre-Messinian	406801	Europe	0	0	0	0	
Permian/Upper Jurassic Composite	520001	North America	0	0	0	0	
Cenomanian-Turonian-Tertiary Composite	603701	Central and South America	0	0	0	0	
Paleozoic	604102	Central and South America	0	0	0	0	
Aguada Bandera	605802	Central and South America	0	0	0	0	
Neocomian Lacustrine	606001	Central and South America	0	0	0	0	
Lower Cretaceous	606002	Central and South America	0	0	0	0	
Permian Coal	804701	South Asia	0	0	0	0	
North Ustyurt Paleozoic	115003	Former Soviet Union	NA	NA	NA	NA	
Xujiahe-Xujiahe/Shaximiao	314203	Asia Pacific	NA	NA	NA	NA	
Central Carpathian Paleogene	404805	Europe	NA	NA	NA	NA	
Neogene	602201	Central and South America	NA	NA	NA	NA	
Jalangi-Sylhet/Burdwan Composite	804702	South Asia	NA	NA	NA	NA	
						Grand Total:	2,393,918